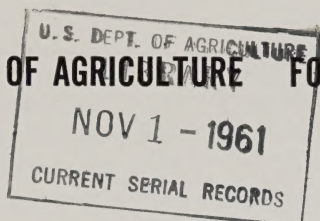


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European Pine Shoot Moth

William E. Miller, Arthur R. Hastings, and John F. Wootten¹

The European pine shoot moth (*Rhyacionia buoliana* (Schiff.)) was first observed in this country in 1913, attacking ornamental Scotch pine (*Pinus sylvestris* L.) on Long Island. Surveys in 1914 showed that it was present in nurseries and on estates in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, West Virginia, Ohio, and Illinois. In 1915, because of this insect, a Federal quarantine prohibited importing pines from Europe.

Beginning about 1925, the shoot moth spread rapidly in southern New England and the north-central United States, largely because of the movement of infested nursery stock in an intensified forest planting program. The insect was detected in southeastern Michigan in 1930, and now occurs in that State in virtually all of the Lower Peninsula and several localities in the Upper Peninsula.

Infestations also are general in northern Ohio, Indiana, and Illinois, and in southeastern Wisconsin (fig. 1), particularly where red pine (*Pinus resinosa* Ait.) has been planted. Outlying infestations have been reported in all the eastern Canadian Provinces, and in the West in British Columbia, Washington, and Oregon.

Host Trees

In the United States, the European pine shoot moth has caused much damage in young plantations of red pine. It has been responsible for reduced planting of red pine in many areas. Although attacked trees rarely if ever die, their growth is inhibited and many are deformed. Scotch pine and Austrian pine (*Pinus nigra* Arnold) are usually not so badly damaged. Swiss mountain pine (*P. mugo* Turra) may be severely attacked, but the resulting dense, bushy growth does not seriously affect the appearance of this ornamental tree. Ponderosa pine (*P. ponderosa* Laws.) planted in the East has been badly injured. White pine (*P. strobus* L.), jack pine (*P. banksiana* Lamb.), and other pines are occasionally attacked when near infested plantings of red or Scotch pines.

¹ Forest entomologists, Forest Service, stationed respectively at Lake States Forest Experiment Station, East Lansing, Mich., Field Office (maintained in cooperation with Michigan State University); Northeastern Forest Experiment Station, Forest Insect Laboratory, New Haven, Conn.; and Central States Forest Experiment Station, Columbus, Ohio.

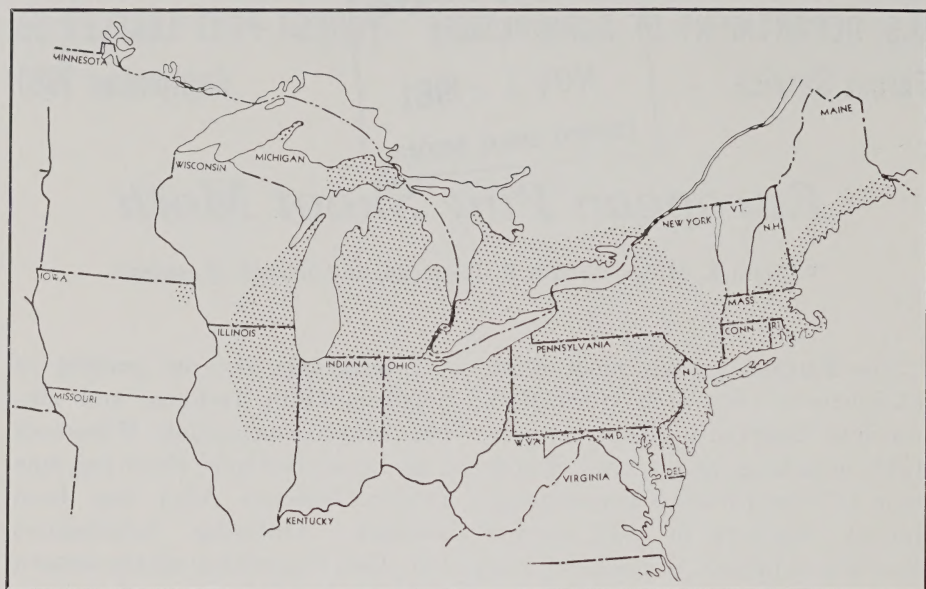


FIGURE 1.—Distribution of the European pine shoot moth in north-central and northeast United States and adjacent Canada.

Evidence of Infestation

Summer and Winter.—The newly hatched larva spins a minute, tent-like web coated with resin and debris in the current year's growth between a needle sheath and the stem. The larva then bores through the needle sheath and mines the base of the needle. Needles damaged in this way often turn yellow or brown by late summer. As the larva grows, it moves to a bud for feeding, forms another tent there, and coats it with resin and debris. The fresh resin on tents may make them glisten on bright days. Later, the resin becomes the solidified, yellowish-white mass characteristic of shoot moth infestations in late summer and during the winter (fig. 2).

Spring.—The larva spins still another, but larger, tent upon emerging in the spring after overwintering either in the bud or under a mass of pitch on the bud. The

spring tent is spun between the bud to be fed upon and one or more nearby buds or needle sheaths. It



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FIGURE 2.—Red pine tip with solidified resin mass broken open to show a partly grown larva.

also is coated with resin and debris. In early spring it may glisten in the sunlight and thereby be conspicuous. The resin solidifies by late spring, forming a yellowish-white mass.

Other evidences of shoot moth infestation are mined buds, which may remain on the tree for years, and the various types of characteristic damage discussed below.

Damage

Severe infestation by the European pine shoot moth inhibits height growth, causes deformations, and thereby lowers the value of future products. In red pine, value losses occur, especially in the first and second commercial thin-

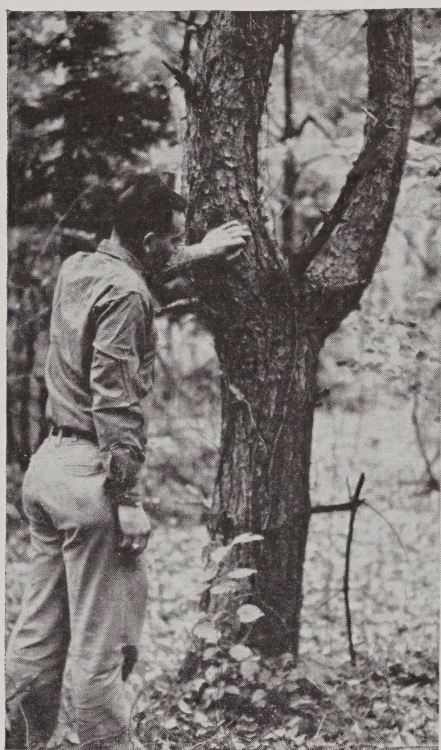
nings, but many trees in time overgrow damage dating from the juvenile period.

When the terminal and lateral buds on a tip are killed, a dead spike top (fig. 3) may result. Adventitious buds often develop from the shoot below this point, forming a dense growth or bush (fig. 3) the following season. Sometimes when the terminal bud is killed, several lateral buds develop into competing leaders, resulting in a forked stem (fig. 4). When a new shoot is not killed but is weakened to a point where it falls over, yet continues to grow, a crook or posthorn (fig. 5) develops. Larval feeding on only one side of a bud can also lead to crook formation.



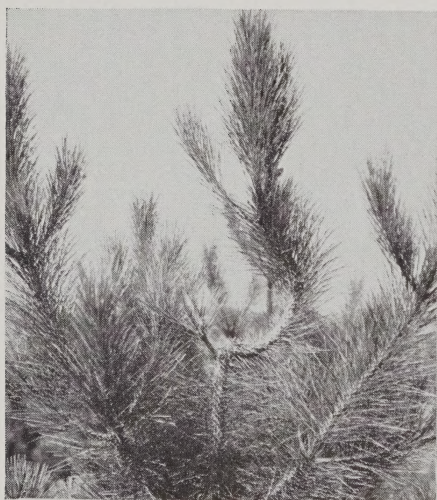
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FIGURE 3.—Badly damaged red pine stand showing spiked and bushy tops.



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FIGURE 4.—Forked trunk of a red pine tree, caused by European pine shoot moth.



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FIGURE 5.—Recently developed posthorn in a red pine tree.

Life History and Description

In June and July, disk-shaped eggs a little smaller in diameter than the width of a red pine needle are deposited, often in overlapping groups, on the twigs, buds, and needles of the tree. At first they are yellow, but later they turn orange and then brown. Hatching occurs a week or two after deposition.

After the summer's feeding the larva hibernates on the host tree, either in a bud or under a mass of pitch on a bud. When hibernating it usually is between the third and fourth molts and is about one-fifth inch long. The first signs of spring feeding are found during April. By late May or early June the larva is full grown and about five-eighths of an inch long. Its body is light brown, and the head and the plates just behind the head and near the tail end are black.

The larva then transforms to a pupa inside its burrow or resinous tent. The pupa is reddish brown and about three-eighths of an inch long. Between 2 and 3 weeks later, the pupa forces itself one-half to three-fourths of the way out of its chamber just before emerging as an adult moth.

The orange forewings of the moth are marked with several irregular silvery lines (fig. 6), and the hindwings are gray. The wing-spread is about three-fourths of an inch.

Usually within the first 24 hours after they emerge, the adults mate and the females begin laying eggs. The egg-laying period lasts for several weeks. During the day adults remain at rest on the trees, flying



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FIGURE 6.—European pine shoot moth adult resting on a shoot.

only when disturbed. They fly spontaneously and vigorously in the evening.

Control

Natural and Cultural.—Within the insect's normal geographic range, winter weather may at times reduce infestations here and there. Overwintering larvae cannot survive temperatures colder than about -20° F. This characteristic determines the northern limits of the shoot moth's range. A good snow cover, however, can successfully insulate infested buds from low temperatures lethal to the larvae.

Several parasitic wasps, which normally attack other insects in eastern North America, have been found attacking shoot moth eggs, larvae, and pupae. In addition, several species that attack the shoot

moth in Europe have been introduced into New England and Ontario and are gradually spreading. However, none of these are yet considered important in control.

On sites where pine growth is rapid, plantations sustain lower larval populations. Also, the number of years in which trees are particularly susceptible to injury is reduced. Although trees growing on such sites usually are not damaged to an important extent, they may be retarded in height growth in their early years. An annual height growth of 15 inches or more in red pine trees frequently indicates that the shoot moth will not cause serious damage (fig. 7). Slow-growing trees usually do not escape serious damage from a shoot moth infestation unless direct protective measures are taken.

On sites where red pine growth is expected to be slow, pines less susceptible to shoot moth attack should be planted if their planting is otherwise feasible. In the Lake States, those less susceptible include Austrian, Scotch, eastern white, and jack pine.

Chemical.—Control of the European pine shoot moth is difficult and expensive. Of the many insecticides tested, DDT has proved the best. To be effective, relatively heavy dosages are necessary, as an adequate insecticidal deposit must be placed around current needle bases and buds. A dosage of 7 to 10 pounds of DDT per acre, in either a dilute "drench" spray applied by hydraulic equipment or in a concentrated spray applied by mistblower, has given good control



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FIGURE 7.—Areas of good and poor growth of red pine in the same plantation. The taller trees (left) are growing more than 15 inches a year, and they show practically no European pine shoot moth damage. A number of the shorter trees (right and foreground), which are growing less than 15 inches a year, have been damaged.

(fig. 8). A large volume of carrier is required with either method. With hydraulic equipment 350 to 500 gallons of mixture are needed per acre. With a mistblower 35 to 50 gallons are needed. However, these dosages are not recommended in forest plantations because of the hazard to wildlife. Airplane spraying has not been effective.

A spray program can be carried out in the spring or summer. Spring spraying should be timed with spring larval activity. Diluted sprays should not be applied earlier than 2 weeks before nor later than 2 weeks after the beginning of spring feeding. Concentrated sprays should be applied only within 1 week after the beginning of spring larval feeding.

Summer spraying should be timed with hatching. Diluted sprays should be applied from a week before to a week after hatch-

ing starts. Concentrated sprays should be applied only within 1 week after hatching.

CAUTION: DDT is poisonous. Store it in a plainly labeled container away from all food. Follow directions and heed precautions given by the manufacturer. Avoid overdosing, especially in the vicinity of streams, ponds, and lakes.

Clipping.—Clipping off infested shoots after mid-June will reduce shoot moth populations. The incidental clipping of infested shoots in pine Christmas tree shaping or shearing operations achieves the same result. The longer this practice is delayed after mid-June, the more effective it is. Its effectiveness at any time is related directly to the proportion of infested shoots removed. Clipped shoots may be allowed to remain on the ground, with little danger of the larvae in them moving back to trees.

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FIGURE 8.—A heavy-duty airblast sprayer applying a concentrated DDT spray for shoot moth suppression in a red pine plantation.



Clipping off infested shoots in the spring, when infestation is most conspicuous, is a possible control measure on ornamental pines and in small plantings. It is usually not feasible except in the early stages of buildups before the shoot moth is very abundant. Shoots clipped in the spring must be destroyed because the insect can complete its life cycle in them and contribute to a new insect generation.

Control in the Nursery

Planting stock should be insect free. Despite the most careful inspections, some infested seedlings may escape detection. Therefore, removal of infested stock should not be relied upon as the only control measure in the nursery.

To control the insect in nursery beds, spray stock with a diluted DDT mixture (1 gallon of 25-percent concentrate in 100 gallons of water). The spraying should be

timed a little before or at the beginning of either spring feeding or hatching in summer. A repeat treatment 7 to 10 days later is also advisable. About 100 gallons of this mixture will treat an acre of nursery beds.

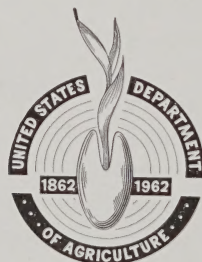
Methyl bromide is very effective for fumigating red pine seedlings. The following dosages will result in almost complete control. The exposure period is 2 hours.

<i>Temperature</i> (°F.)	<i>Dosage of methyl bromide per 1,000 cubic feet (pounds)</i>
40	8
50	6
60	4

CAUTION: Methyl bromide, an extremely poisonous chemical, should be used only under strict compliance with recommended safe-operating procedures.

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